ADSORPTION AND MIGRATION STUDIES FOR NUCLEAR WASTE MANAGEMENT

Ceren Kütahyalı

Ege University Institute of Nuclear Sciences,
35100, Bornova, Izmir, Turkey
ceren.kutahyali@ege.edu.tr

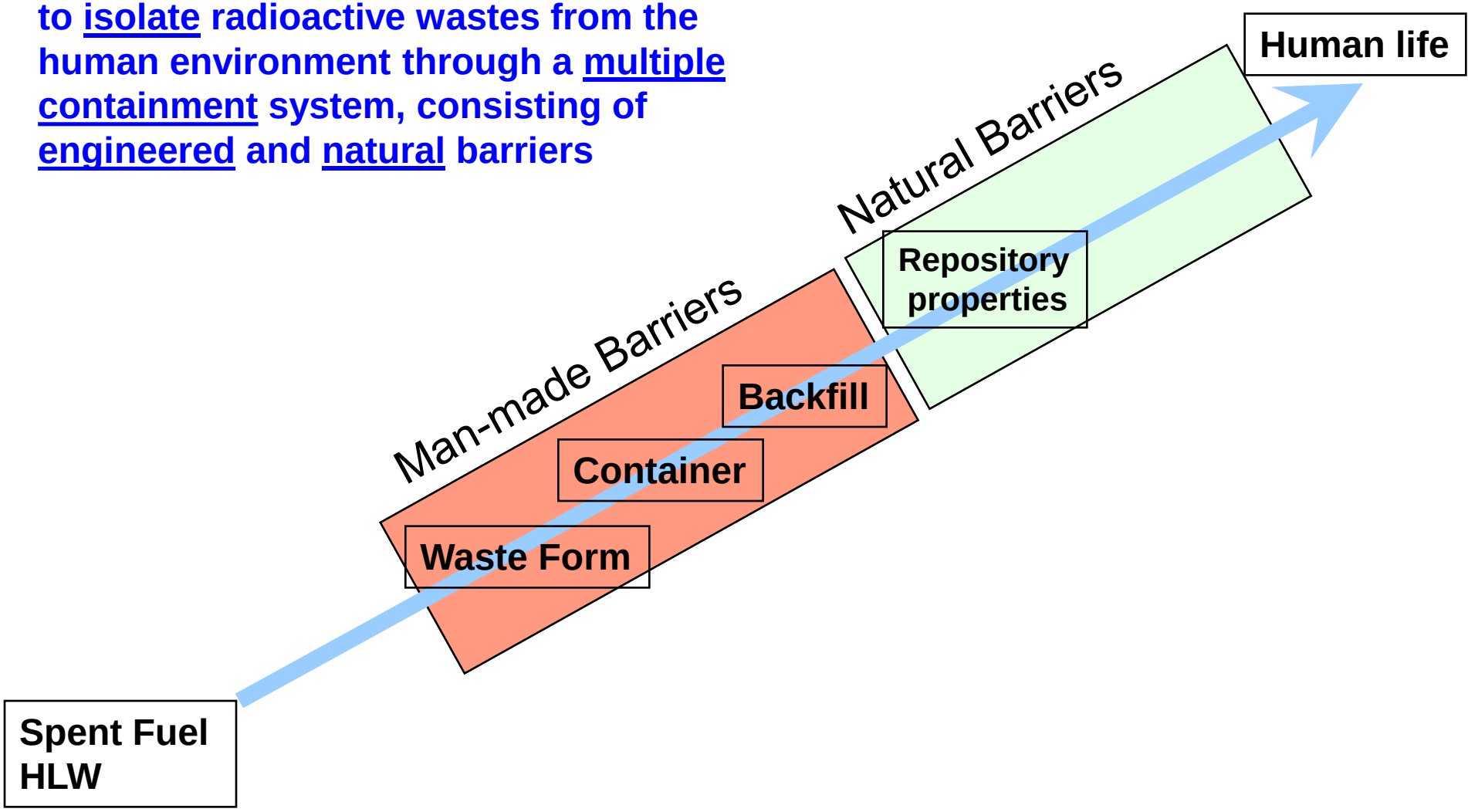
- 1998- 2004 : Research Assistant, Ege University Institute of Nuclear Sciences, İzmir, Turkey
- 2006-2008 : Postdoctoral Researcher, EU-JRC Institute for Transuranium Elements, Karlsruhe, Germany
- 2004- : Assistant Professor, Ege University, Institute of Nuclear Sciences, İzmir, Turkey

PhD Thesis: Investigation of the Selective Uranium Adsorption on Activated Carbon Prepared from Charcoal and Its Applications

Deep geological disposal

Rationale

to isolate radioactive wastes from the human environment through a multiple containment system, consisting of engineered and natural barriers



Adsorbents used in the Studies for Radioactive Waste Management

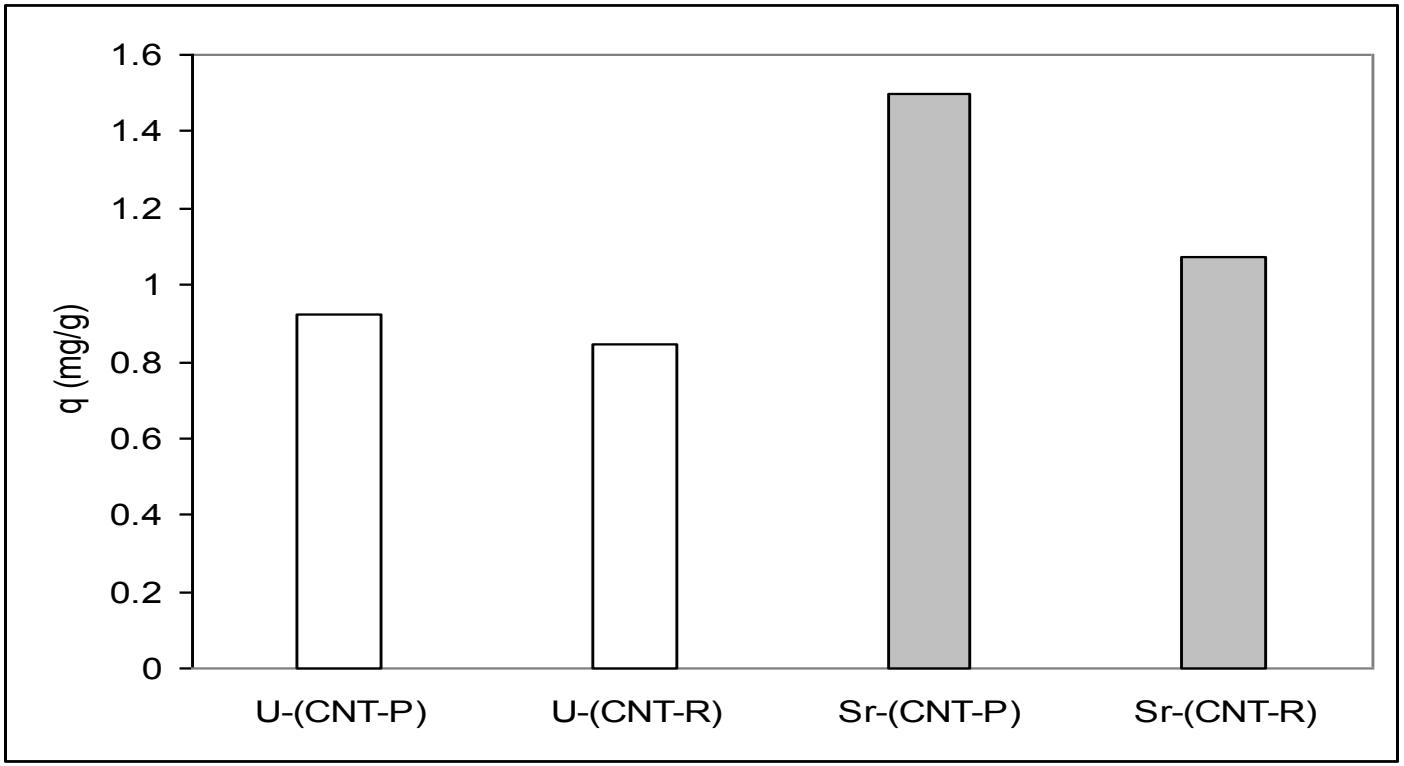
- Commercial activated carbons
- Activated carbon from olive stones
- Activated carbon from charcoal
- Carbonnanotubes
- Fibers
- Plant leaves
- Seawage sludge
- Activated carbon – (Zr-Si) mixed oxides

Carbon Nanotubes (CNTs) for Waste Management

- CNT adsorption and retention properties make this material a promising candidate for applications in
  - environmental remediation,
  - treatment of liquid effluents from nuclear plants,
  - conditioning/immobilization of fission products and actinides.
- The aim of this work is to discuss potential applications in the field of nuclear waste management.

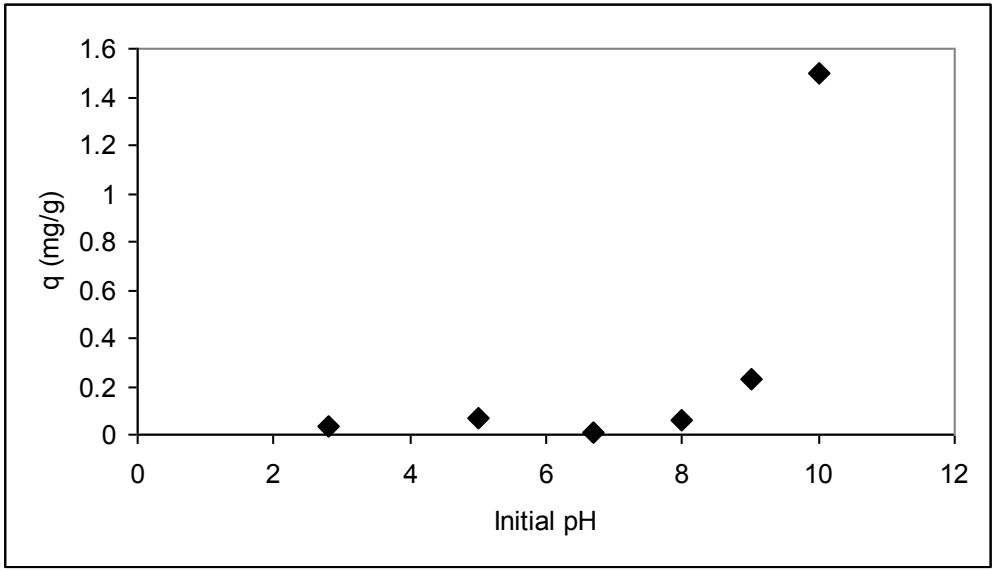
- Multiwalled carbon nanotubes (Sigma-Aldrich)
- Modification of the surface with HNO_3 (8 M HNO_3)
  Functional groups generation on the surface

Effect of acid treatment on adsorption

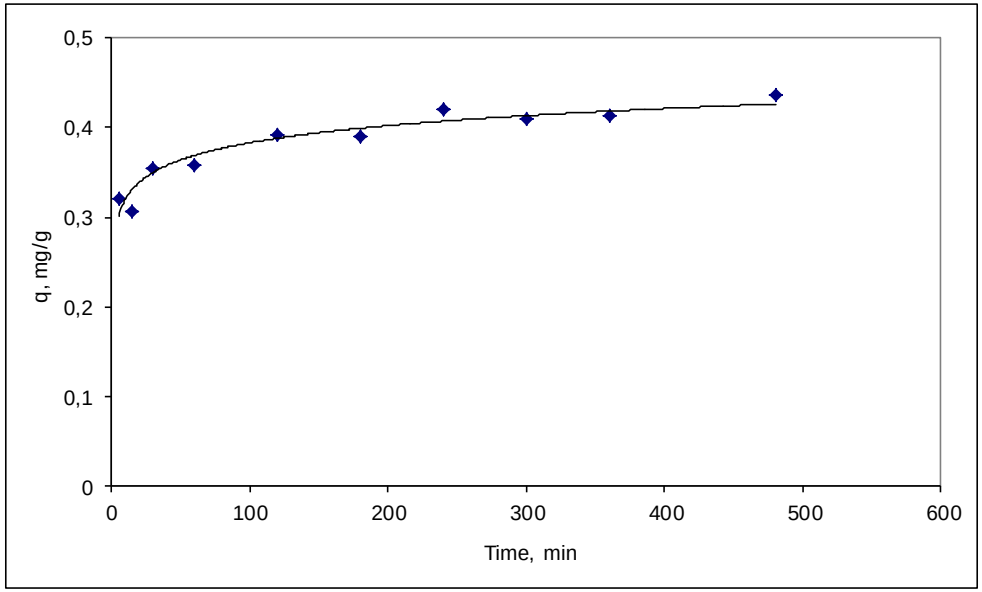


- 50 mg of MWCNTs
- initial metal concentration was 10 mg L^{-1}
- room temperature
- 4 h shaking time

Adsorption experiments



- Initial Sr concentration: 10 mg L^{-1}
- amount of the adsorbent: 50 mg
- room temperature
- 4 h shaking time



- Initial Sr concentration: 10 mg L^{-1}
- amount of the adsorbent: 50 mg
- room temperature
- pH 10

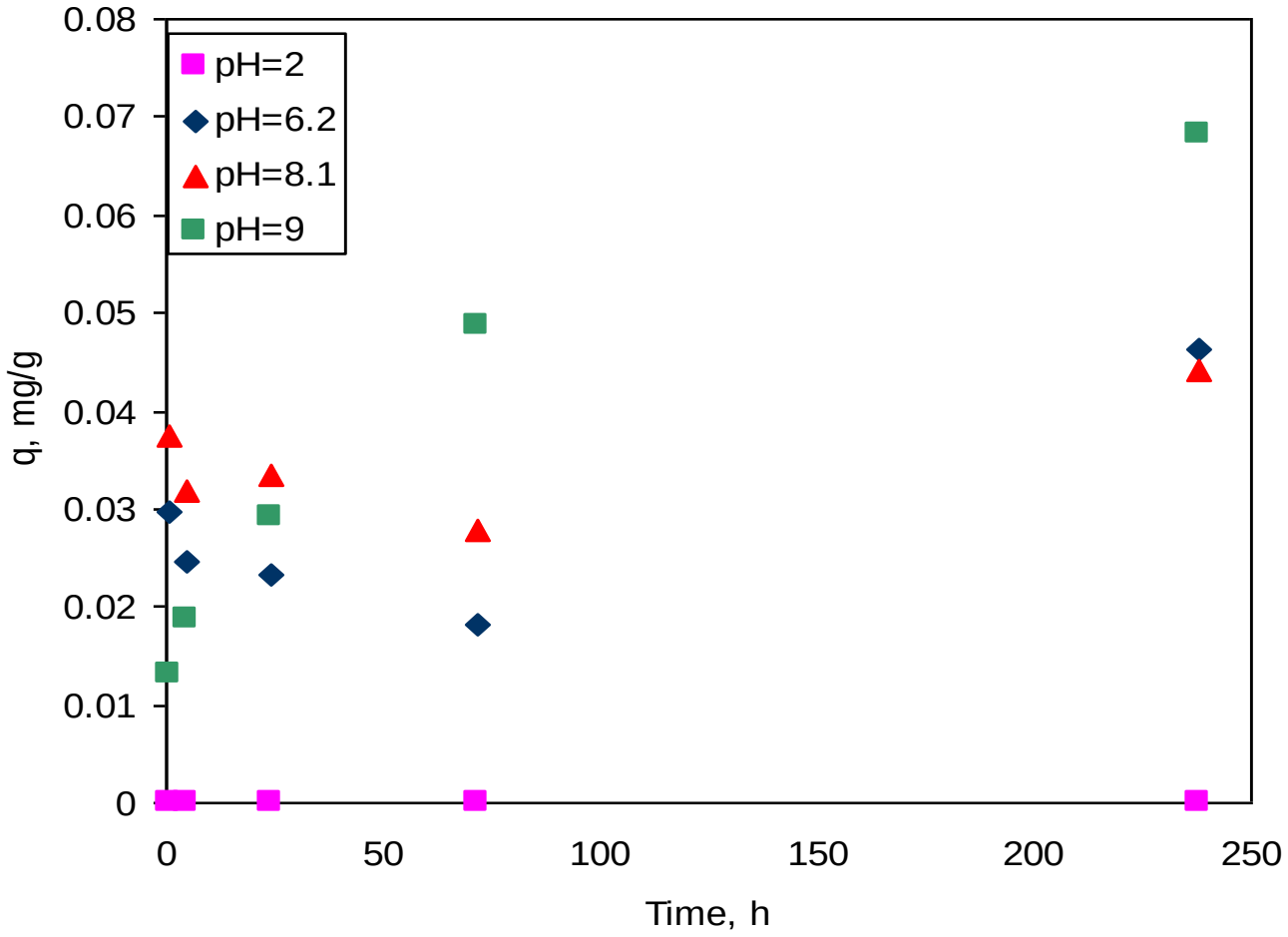
Precipitation/Adsorption Behaviour of Th on CeO_2 Surfaces

- The release of radionuclides from used fuel is a complex process.
- The dissolution rate of the used fuel is limited by the solubility of the fuel.
- The transport of some of the radionuclides released from the fuel may also restricted by precipitation.
- The behavior of thorium is important while modeling radionuclide release from nuclear fuel containing Th in deep underground waste repositories.
- In the case of ThMOX fuel, possible contact with water cause dissolving the fuel matrix as well as precipitation on the surfaces of the fuel pellets.
- In order to understand this behaviour of the ThMOX fuel, Th precipitation/adsorption experiments were designated.
- Pu is simulated with Ce and experiments were conducted using CeO_2 pellets.

Experimental conditions

- Static sequential experiments
- Ambient atmosphere
- Volume 35 mL
  - De-mineralized water pH=6,2
  - Carbonate water (1 mM $NaHCO_3$+10mM NaCl) pH=8,1
  - Carbonate water (20mM $NaHCO_3$+10mM NaCl) pH=9
  - Acidic solution pH=2
- Room temperature
- Th concentration of 4.1×10^{-6} mol/L

Sorption of Th on CeO_2 pellets as a function time

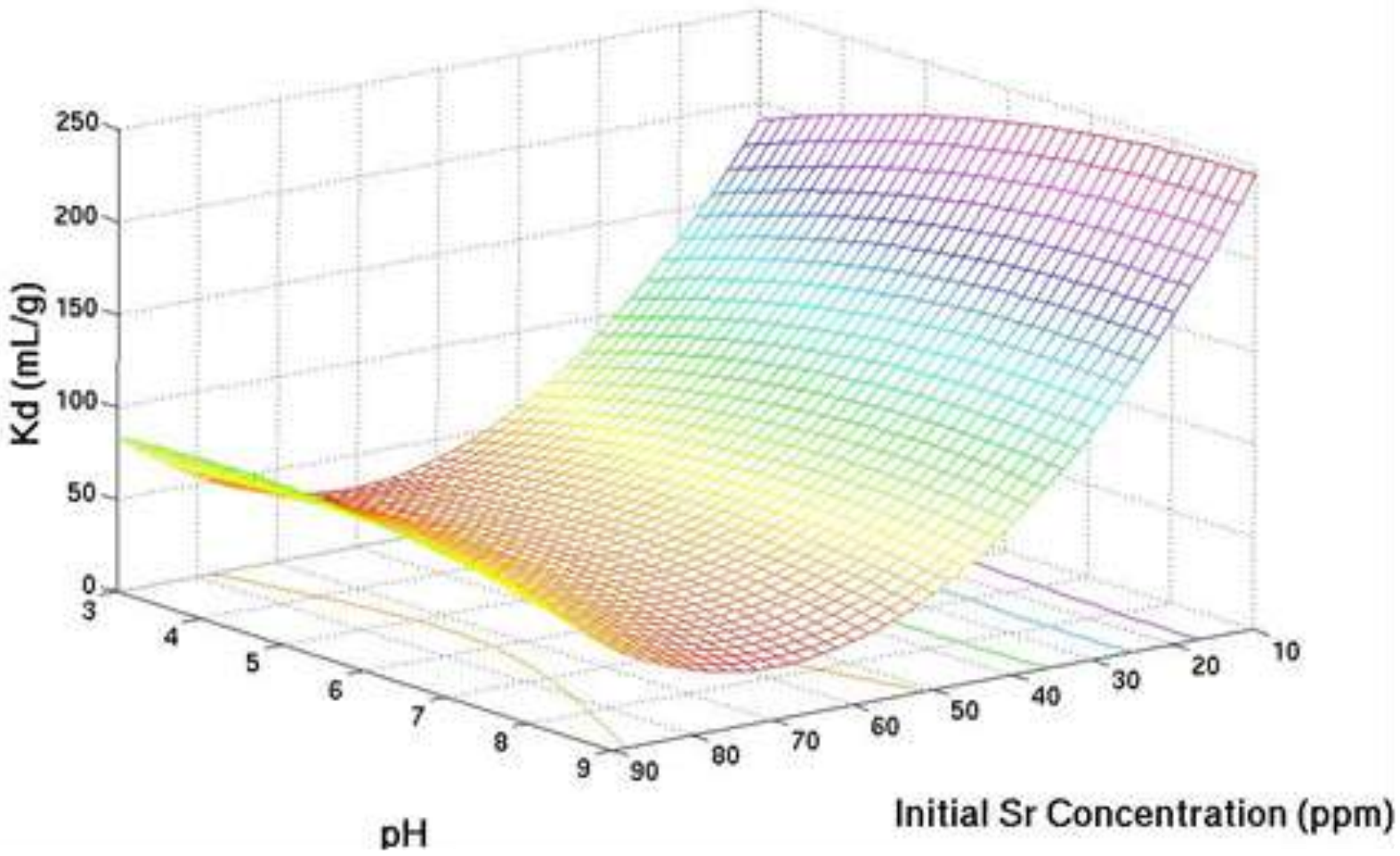


Migration Studies

- In planning the disposal of radioactive waste in a deep geologic repository, consideration must be given to the ways in which radionuclides might leave the repository and migrate through the geosphere.
- In performance assessment studies the uptake of the radioactive elements by rock formations play an important role in retarding their aqueous phase migration.
- Sorption studies of radionuclides have been conducted to obtain data on the distribution coefficient (K_d) that is as an input parameter in the performance assessment of the geological disposal of radioactive wastes.

$$K_d = \frac{\text{Mass of adsorbate sorbed (mg/g)}}{\text{Mass of adsorbate in solution (mg/mL)}}$$

- Sorption experiments were studied in a batch sorption system using $Sr(NO_3)_2$ solution.
- Granitic rock samples were used
- Central Composite Design was used in the experiments. Sr sorption was studied as a function of pH, temperature, initial concentration of adsorbate and contact time.



Response surface graphs for interactions of investigated parameters of Sr^{2+} adsorption onto non-treated Kula volcanics.
Effect of pH and initial Sr^{2+} concentration

Thank you...